
XX. Introductory Physics, High School

High School Introductory Physics Test

The spring 2010 high school MCAS Introductory Physics test was based on learning standards in the Physics content strand of the Massachusetts *Science and Technology/Engineering Curriculum Framework* (2006). These learning standards appear on pages 74–77 of the *Framework*.

The *Science and Technology/Engineering Curriculum Framework* is available on the Department website at www.doe.mass.edu/frameworks/current.html.

In test item analysis reports and on the Subject Area Subscore pages of the MCAS *School Reports* and *District Reports*, Introductory Physics test results are reported under the following four MCAS reporting categories:

- Motion and Forces
- Heat and Heat Transfer
- Waves and Radiation
- Electromagnetism

Test Sessions

The MCAS high school Introductory Physics test included two separate test sessions, which were administered on consecutive days. Each session included multiple-choice and open-response questions.

Reference Materials and Tools

Each student taking the high school Introductory Physics test was provided with an Introductory Physics Formula Sheet. A copy of this formula sheet follows the final question in this chapter.

Each student also had sole access to a calculator with at least four functions and a square-root key.

The use of bilingual word-to-word dictionaries was allowed for current and former limited English proficient students only, during both Introductory Physics test sessions. No other reference tools or materials were allowed.

Cross-Reference Information

The table at the conclusion of this chapter indicates each item's reporting category and the framework learning standard it assesses. The correct answers for multiple-choice questions are also displayed in the table.

Introductory Physics

SESSION 1

DIRECTIONS

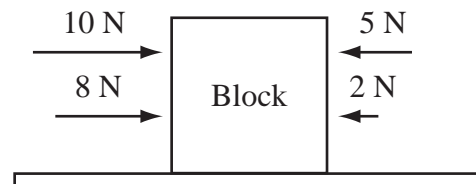
This session contains twenty-one multiple-choice questions and two open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

- 1 A balloon is inflated with room-temperature air and then put in a sunny place. The balloon expands slightly due to a rise in temperature.

Which of the following **best** describes the molecules of air inside the balloon when the balloon is left in the sunlight as compared to when it was first inflated?

- A. The molecules are moving faster.
- B. There are more molecules in the balloon.
- C. There are fewer interactions between the molecules.
- D. The molecules stop colliding with the walls of the balloon.

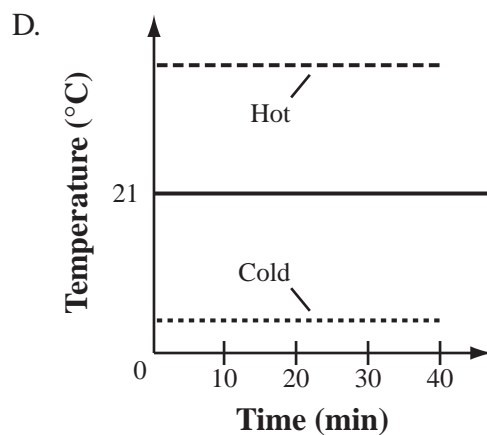
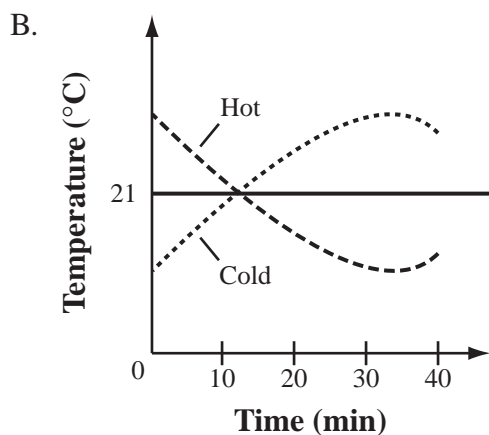
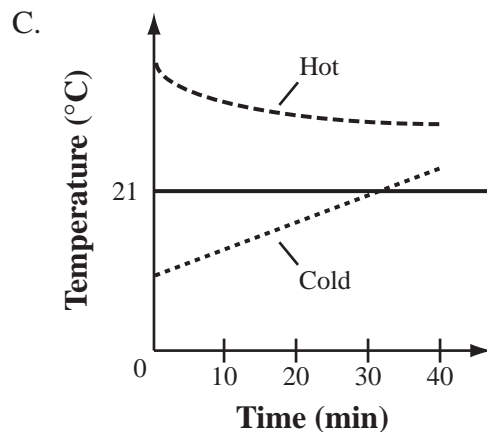
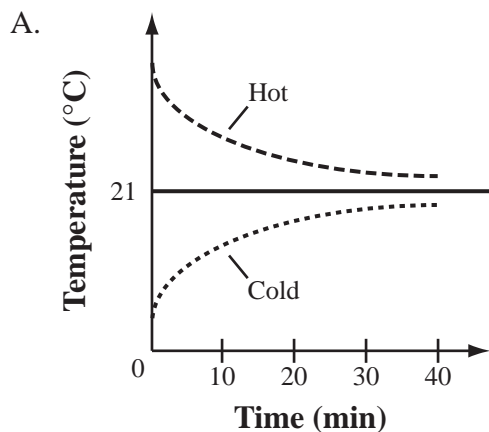
- 2 Four students push on a block of wood with the forces shown in the diagram below. Assume friction is negligible.



The block slides horizontally. What is the net force acting on the block of wood?

- A. 3 N to the left
- B. 8 N to the left
- C. 11 N to the right
- D. 25 N to the right

- 3 A cup containing 25 mL of hot water and a similar cup containing 25 mL of cold water are placed on a table in a room at 21°C . Which of the following graphs shows the **most likely** change in temperature for each cup from 0 min to 40 min?



- 4 Which of the following properties is the same for all electromagnetic waves in a vacuum?

A. amplitude
B. frequency
C. speed
D. wavelength

- 5 An elevator in an office building completed the following trips:

- 1st floor to 8th floor
- 8th floor to 4th floor
- 4th floor to 13th floor

The distance between each floor of the office building is 3.0 m.

Which table shows the total distance traveled and displacement of the elevator?

A.

Distance	Displacement
33 m	60 m

B.

Distance	Displacement
60 m	36 m

C.

Distance	Displacement
36 m	60 m

D.

Distance	Displacement
60 m	60 m

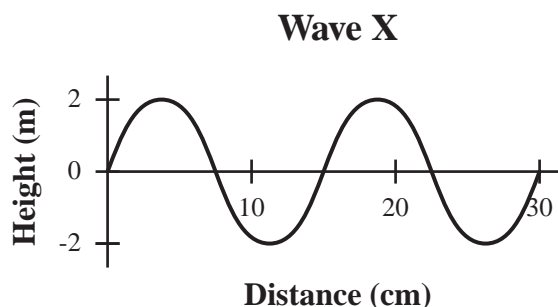
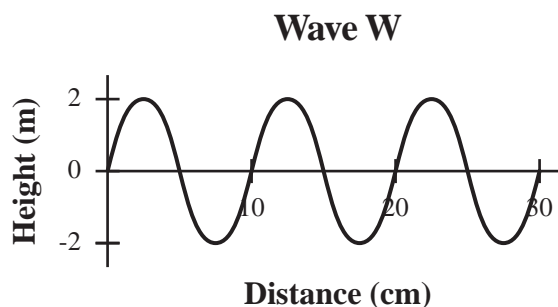
- 6 Which of the following conditions results in the buildup of static charge on an object?
- A. when neutrons outnumber electrons
 - B. when there are more protons than neutrons
 - C. when there are more electrons than protons
 - D. when all neutrons have been removed from the object
- 7 What is the voltage across the terminals of a $23\ \Omega$ resistor that has $0.065\ \text{A}$ of current flowing through it?
- A. $0.0028\ \text{V}$
 - B. $0.097\ \text{V}$
 - C. $1.5\ \text{V}$
 - D. $350\ \text{V}$
- 8 The momentum of an object in space is
- A. dependent on its mass.
 - B. independent of its inertia.
 - C. independent of its velocity.
 - D. dependent on its potential energy.
- 9 Which of the following is an example of heat transfer by conduction?
- A. sunlight heating a floor
 - B. an electric stove heating an iron pan
 - C. a wood stove heating nearby objects through electromagnetic waves
 - D. an electric heater heating air, which rises and is replaced with cooler air

- 10 In a competition, weightlifter 1 lifts a 100 kg weight from the floor. Weightlifter 2 also lifts a 100 kg weight to the same height above the floor, but takes a longer time to do so.

Which of the following statements describes the work done and the power used by the weightlifters?

- A. Weightlifter 2 does the same work and uses less power compared with weightlifter 1.
- B. Weightlifter 2 does less work and uses the same power compared with weightlifter 1.
- C. Weightlifter 2 does the same work and uses more power compared with weightlifter 1.
- D. Weightlifter 2 does more work and uses the same power compared with weightlifter 1.

- 11 The graphs below give information for waves W and X. Both waves were produced in the same medium and are moving at the same speed.



Which of the following statements describes another property of these waves?

- A. Wave W has a larger period than wave X.
- B. Wave W has a lower frequency than wave X.
- C. Wave W has a greater amplitude than wave X.
- D. Wave W has a shorter wavelength than wave X.

Question 12 is an open-response question.

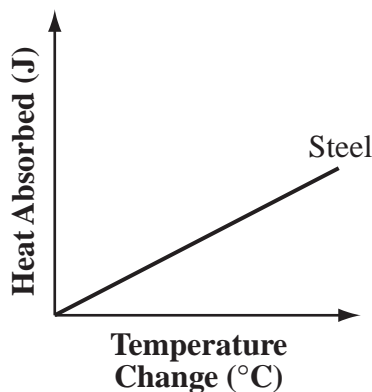
- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 12 in the space provided in your Student Answer Booklet.

- 12** A car's brakes absorb a large amount of energy and heat up as the car slows down and stops. Several materials with different thermal properties have been used for car brakes. In the table below, the specific heat capacities of three of these materials are shown.

Material	Specific Heat Capacity ($\text{J/g} \cdot ^\circ\text{C}$)
aluminum	0.897
carbon-ceramic	1.123
steel	0.449

In an experiment, 500 g each of aluminum, carbon-ceramic, and steel are heated and their temperature changes are recorded. The amount of heat absorbed and the temperature change for the 500 g sample of steel are shown in the graph below.



- a. In your Student Answer Booklet, copy the graph.
- Draw a line on your graph to show the relationship expected for the 500 g sample of aluminum.
 - Draw a line on your graph to show the relationship expected for the 500 g sample of carbon-ceramic.
 - Identify each line on your graph, and explain why you drew each line where you did.
- b. If brake materials get too hot they soften or melt, resulting in loss of braking power. Of the three materials in the table, which is **best** suited to resist large changes in temperature? Explain your answer.

Mark your answers to multiple-choice questions 13 through 22 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

- 13 Which of the following properties determines a color in the visible light region of the electromagnetic spectrum?

A. acceleration
B. amplitude
C. frequency
D. speed

- 14 The source of a sound is moving away from an observer who is standing still. How do the sound waves received by the observer compare with those emitted by the source?

A. They are heard as having a greater velocity.
B. They are heard as having a higher frequency.
C. They are heard as having a lower frequency.
D. They are heard as having a smaller wavelength.

- 15 The diagram below shows a simple electric circuit.



Which of the following statements describes the function of the battery?

- A. It reduces the flow of electrons.
B. It transmits light through the circuit.
C. It pushes electrons through the circuit.
D. It releases light during a chemical reaction.
- 16 When a student listens to music, sound waves propagate from the speaker to her ear. Which of the following is a physical description of this process?
- A. Particles produced at the speaker move to the student's ear.
B. Energy is transported from the speaker to the student's ear.
C. Material is transferred from the speaker to the student's ear.
D. Clusters of air molecules are sent from the speaker to the student's ear.

17 Which of the following statements **best** describes the force of Earth's gravity on a rocket moving upward?

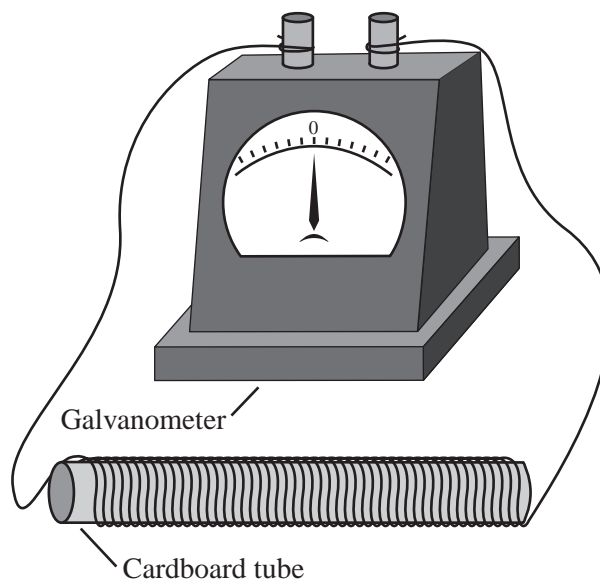
- A. The gravitational force is constant for all altitudes.
- B. The gravitational force is weaker when the rocket is higher.
- C. The gravitational force is stronger when the rocket is higher.
- D. The gravitational force is zero when the altitude is greater than 10,000 miles.

18 A student swings a bat horizontally, making contact with a ball thrown to her. The ball leaves the bat, and the bat continues moving through the rest of the swing.

Which of the following statements describes the change in energy necessary to do work on the ball?

- A. All the kinetic energy of the bat is converted to work.
- B. All the potential energy of the bat is converted to work.
- C. Some of the kinetic energy of the bat is converted to work.
- D. Some of the potential energy of the bat is converted to work.

19 The diagram below shows copper wire wrapped around a cardboard tube, which is then attached to a galvanometer. A galvanometer detects and measures small amounts of electric current.



Which of the following would cause the galvanometer needle to move?

- A. wrapping additional wire around the tube
- B. uncoiling the wire wrapped around the tube
- C. moving a magnet back and forth inside the tube
- D. moving an aluminum block up and down inside the tube

- 20 A star suddenly explodes. Which of the following types of waves reach Earth's surface?

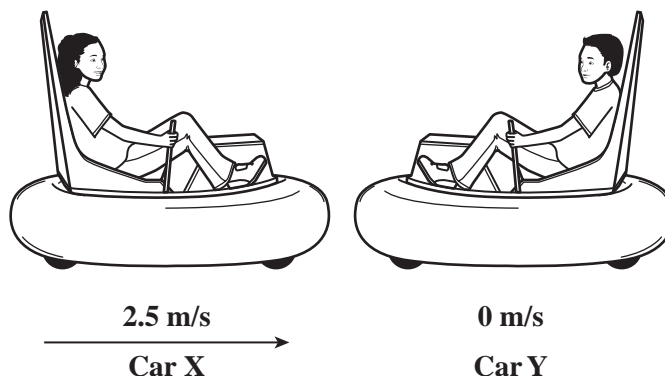
A. light only
B. sound only
C. sound followed by light
D. light followed by sound

- 21 A ball is thrown straight upward. The ball's initial speed is 30 m/s and its mass is 0.05 kg, resulting in an initial kinetic energy of 22.5 J.

If the initial potential energy of the ball is 10 J and there is no frictional force, what would be the ball's total energy while it is moving?

A. 0.0 J
B. 10.0 J
C. 22.5 J
D. 32.5 J

- 22 At an amusement park, bumper car X moves at a speed of 2.5 m/s toward car Y, which is at rest, as shown in the diagram below.



Car X collides with car Y. How does the momentum of each car change after the collision?

- A. Car X's momentum increases, and car Y's momentum decreases.
B. Car X's momentum decreases, and car Y's momentum increases.
C. Car X's momentum is unchanged, and car Y's momentum increases.
D. Car X's momentum is unchanged, and car Y's momentum decreases.

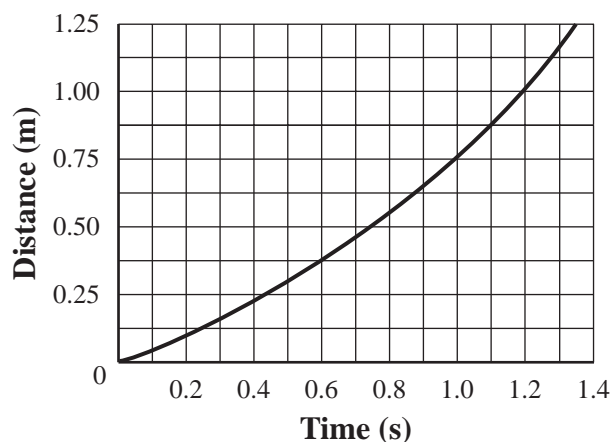
Question 23 is an open-response question.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

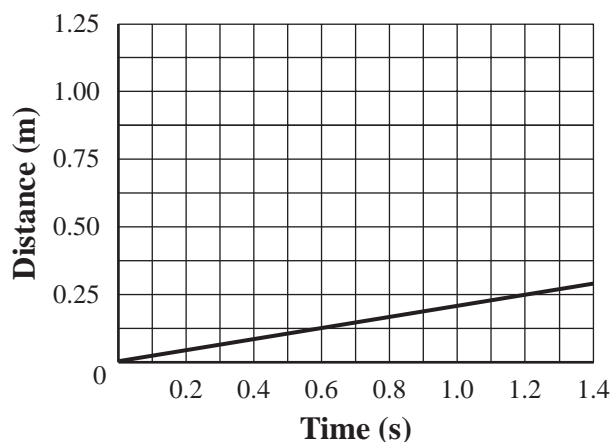
Write your answer to question 23 in the space provided in your Student Answer Booklet.

- 23** A student is conducting experiments with a block of wood. In experiment 1, the student pulls the block of wood with a constant force of 10 N along a horizontal surface. In experiment 2, the student pulls the same block of wood with a constant force of 10 N. The type of surface is different from that used in experiment 1. The results of experiments 1 and 2 are shown below.

Experiment 1



Experiment 2



- Using information from the graphs, compare the surface in experiment 2 with the surface in experiment 1.
- Determine both the magnitude of the force of friction **and** the net force on the block that are required to achieve the results shown in the graph for experiment 2. Include units in your answer.
- Without changing the type of surface used when pulling the block of wood, list one other change to experiment 1 that would produce the results of experiment 2. Explain your reasoning with reference to the frictional force.

Introductory Physics

SESSION 2

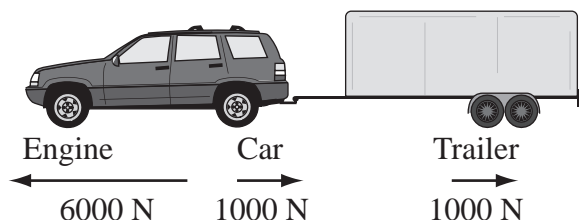
DIRECTIONS

This session contains nineteen multiple-choice questions and three open-response questions. Mark your answers to these questions in the spaces provided in your Student Answer Booklet. You may work out solutions to multiple-choice questions in the test booklet.

- 24 Which of the following actions would increase the current through a circuit component?
- A. decreasing the power in the component
 - B. increasing the resistance of the component
 - C. increasing the voltage across the component
 - D. placing another identical component in series in the circuit

- 25 The specific heat of wood is about $1,700 \text{ J/kg} \cdot ^\circ\text{C}$. How much energy is required to heat a 12 kg piece of wood from 20°C to 30°C ?
- A. 1,400 J
 - B. 17,000 J
 - C. 204,000 J
 - D. 612,000 J

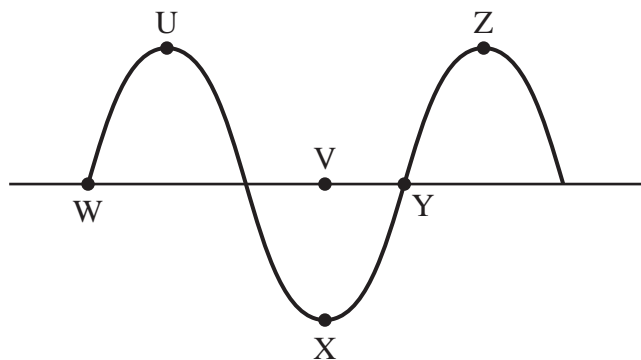
- 26 A 2000 kg car is pulling a 1000 kg trailer. The car's engine exerts a 6000 N force to move the car and the trailer. In addition, the car and the trailer each experience a 1000 N frictional force as they are being pulled, as represented below.



What is the magnitude of the net force on this system?

- A. 2000 N
- B. 4000 N
- C. 5000 N
- D. 8000 N

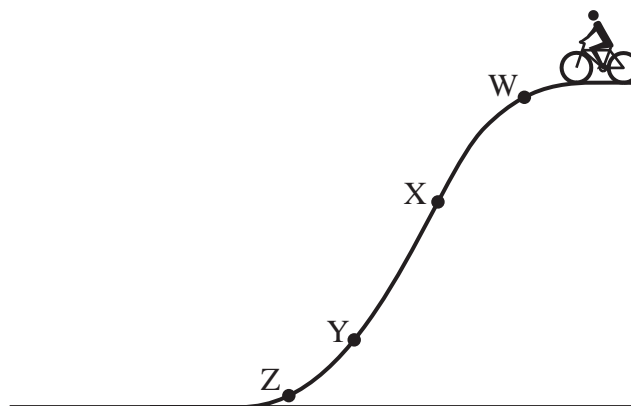
- 27 A teacher asks a group of students to use a ruler to measure the amplitude of the wave shown below.



Between which of the following points should the amplitude be measured?

- A. points U and Z
- B. points V and X
- C. points W and Y
- D. points X and Z

- 28 The diagram below represents a bicyclist at the top of a hill, with four points labeled W, X, Y, and Z.



Assume that the bicyclist does not apply the brakes as he rides down the hill. At which point will the bicyclist's kinetic energy be closest to zero?

- A. point W
- B. point X
- C. point Y
- D. point Z

- 29 Which of the following is designed to produce an electromagnetic wave?
- A. elastic cord
 - B. laser pointer
 - C. metal spring
 - D. ripple tank
- 30 Two full 2 L bottles of water are placed on a table. Bottle 1 was just removed from a refrigerator; bottle 2 is at room temperature.
- Which of the following statements describes the average molecular kinetic energy and the speed of the molecules in each bottle?
- A. Bottle 1 has the same average molecular kinetic energy as bottle 2, and the molecules have the same average speed in both bottles.
 - B. Bottle 1 has a smaller average molecular kinetic energy than bottle 2, and the molecules have the same average speed in both bottles.
 - C. Bottle 1 has a smaller average molecular kinetic energy than bottle 2, and the molecules have a slower average speed in bottle 1 than in bottle 2.
 - D. Bottle 1 has a larger average molecular kinetic energy than bottle 2, and the molecules have a slower average speed in bottle 1 than in bottle 2.
- 31 Which of the following statements describes a result of Earth's gravitational pull on the Moon?
- A. The Moon has craters.
 - B. The Moon orbits around Earth.
 - C. The Moon lacks an atmosphere.
 - D. The Moon has less gravity than Earth.

Question 32 is an open-response question.

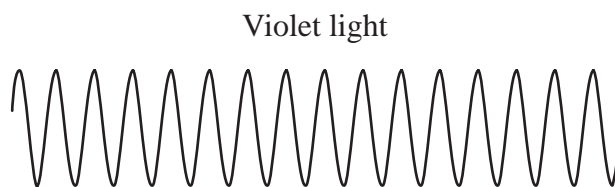
- **BE SURE TO ANSWER AND LABEL ALL PARTS OF THE QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 32 in the space provided in your Student Answer Booklet.

32 When some elements are put into a flame, they emit colored light. Yellow light is emitted from one element and violet light is emitted from another element.

- a. Describe the differences between yellow light and violet light in terms of frequency **and** wavelength.

The diagram below represents violet light.



- b. Copy the diagram of violet light into your Student Answer Booklet. Below your diagram, draw and label a representation of yellow light that illustrates how its frequency and wavelength are different from that of violet light.
- c. Yellow light and violet light are both in the visible range of the electromagnetic spectrum. Identify **two** other similarities between yellow light and violet light.

Mark your answers to multiple-choice questions 33 through 43 in the spaces provided in your Student Answer Booklet. Do not write your answers in this test booklet, but you may work out solutions to multiple-choice questions in the test booklet.

- 33 A microwave oven uses 10 A of current when connected to a wall outlet that provides 120 V of electricity. What is the resistance of the microwave oven?

A. $0.083\ \Omega$
B. $12\ \Omega$
C. $110\ \Omega$
D. $1200\ \Omega$

- 34 Two students are standing next to each other on a level field. One of the students throws a table tennis ball forward toward a line 2.0 m away. At the same time, the second student throws a bowling ball in the same direction. Both balls take the same time to travel the 2.0 m.

Only the second student feels a noticeable backward push when she throws her ball.

Which of the following statements explains why only the second student feels a noticeable backward push?

A. The bowling ball exerts a much larger reaction force.
B. The bowling ball undergoes a much larger acceleration.
C. The bowling ball requires more force to overcome gravity.
D. The bowling ball converts more inertia into kinetic energy.

- 35 A copper sphere, a glass sphere, a plastic sphere, and a rubber sphere are placed on individual insulating stands. A student touches each sphere with an electrically charged object.

The sphere made of which material will distribute the electric charge fastest over its entire surface area?

A. copper
B. glass
C. plastic
D. rubber

- 36 A person is using a force of 200 N to push a box. How much power does the person need to push the box a distance of 4 m in 10 s?

A. 40 W
B. 80 W
C. 200 W
D. 500 W

- 37 Which of the following will **always** change when an object accelerates?

A. mass
B. potential energy
C. velocity
D. weight

- 38 In a television set with a cathode ray tube display, a beam of negatively charged particles called cathode rays passes by a positively charged plate. The beam is deflected before it hits the television screen to produce an image. Which of the following changes would result in the **greatest** increase in the attraction between the negatively charged particles in the beam and the positively charged plate?

A. increasing the distance between the plate and the particles and increasing the charge on the plate
B. increasing the distance between the plate and the particles and decreasing the charge on the plate
C. decreasing the distance between the plate and the particles and increasing the charge on the plate
D. decreasing the distance between the plate and the particles and decreasing the charge on the plate

- 39 Which of the following would cause a change in the speed of a mechanical wave?

A. the wave moving through a liquid
B. the wave moving from a solid to a gas
C. the wave being made by a larger vibration
D. the wave being made by a smaller vibration

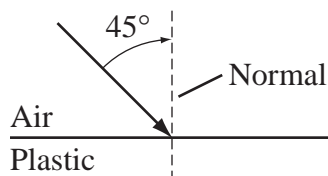
- 40 The table below shows the time it takes four cars to go from 0 to 60 km/h.

Car	Time (s)
1	2.5
2	4.2
3	5.2
4	3.3

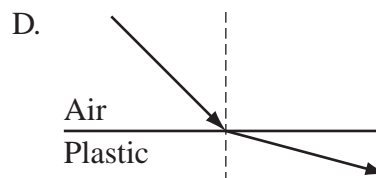
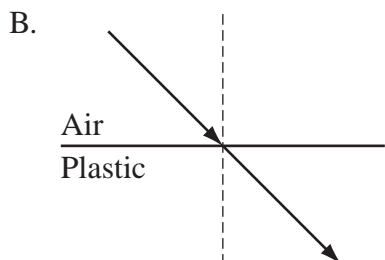
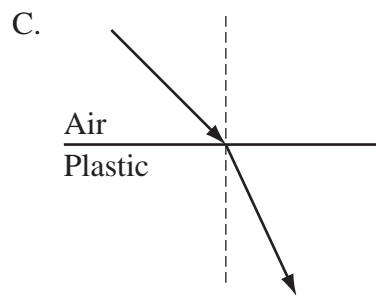
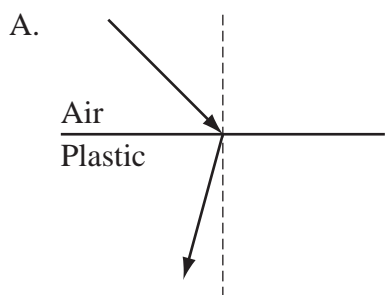
Based on the information given, which of the following quantities can be compared for the four cars?

A. average acceleration
B. instantaneous speed
C. stopping distance
D. stopping time

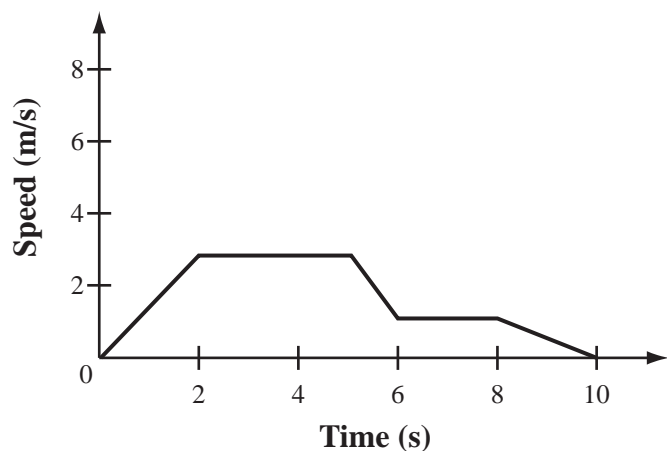
- 41 The diagram below shows a light ray striking the flat surface of a piece of clear hard plastic at an angle of 45° . Light travels faster in air than through plastic.



Which of the following diagrams shows how the ray is refracted after it travels through the plastic?



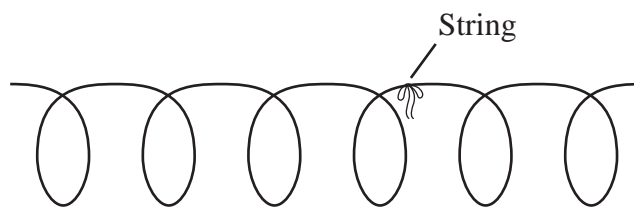
- 42 The graph below shows the speed of an object during a 10 s time interval.




In which of the following time intervals is the speed of the object decreasing?

- A. between 0 s and 2 s
- B. between 2 s and 4 s
- C. between 6 s and 8 s
- D. between 8 s and 10 s


- 43 A string is tied on a spring. Two students then stretch out the spring, as shown below.



In which of the following ways does the string move when the students generate a longitudinal wave in the spring?

A. 

B. 

C. 

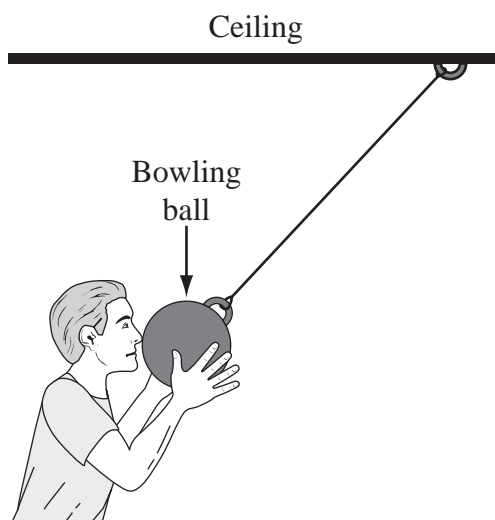
D. 

Questions 44 and 45 are open-response questions.

- **BE SURE TO ANSWER AND LABEL ALL PARTS OF EACH QUESTION.**
- **Show all your work (diagrams, tables, or computations) in your Student Answer Booklet.**
- **If you do the work in your head, explain in writing how you did the work.**

Write your answer to question 44 in the space provided in your Student Answer Booklet.

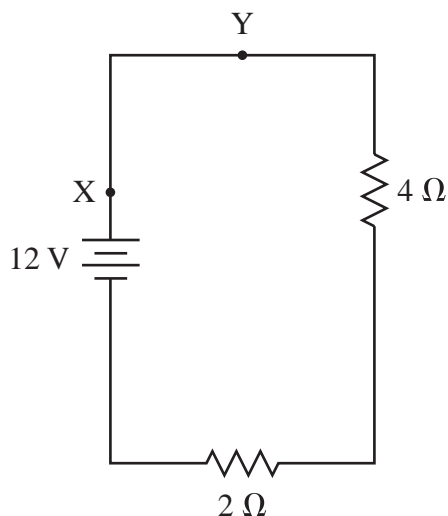
- 44** A pendulum is made with a bowling ball as the bob and a wire attached to the ceiling, as shown in the illustration below. The person in the illustration pulls the bowling ball back until it touches his nose, then releases the bowling ball. Assume that he does not move.



- Describe the changes in the potential energy and the kinetic energy of the bowling ball as it swings back and forth.
- Explain whether the bowling ball will hit the person's nose. Include a discussion of energy changes in your explanation.
- Explain what will happen if the person gives the bowling ball a small push as it is released. Include a discussion of energy changes in your explanation.

Write your answer to question 45 in the space provided in your Student Answer Booklet.

- 45 The diagram below shows a circuit with a 12 V battery connected in series with a $4\ \Omega$ resistor and a $2\ \Omega$ resistor. Two points in the circuit are labeled X and Y.



- Calculate the current in the circuit. Show your calculations and include units in your answer.
- Calculate the voltage drop across the $4\ \Omega$ resistor. Show your calculations and include units in your answer.
- Determine the voltage drop between point X and point Y. Explain the reasoning for your answer.
- Calculate the power of the entire circuit. Show your calculations and include units in your answer.

Massachusetts Comprehensive Assessment System

Introductory Physics Formula Sheet

Formulas

$$\text{Average Speed} = \frac{d}{\Delta t}$$

$$F = ma$$

$$p = mv$$

$$\text{Average Acceleration} = \frac{\Delta v}{\Delta t}$$

$$F = G \frac{m_1 m_2}{d^2}$$

$$V = IR$$

$$\text{Average Velocity} = \frac{\Delta x}{\Delta t}$$

$$F = k \frac{q_1 q_2}{d^2}$$

$$P = IV$$

$$v_f = v_i + a\Delta t$$

$$KE = \frac{1}{2}mv^2$$

$$Q = mc\Delta T$$

$$\Delta x = v_i \Delta t + \frac{1}{2}a \Delta t^2$$

$$PE = mg\Delta h$$

$$v = f\lambda$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$W = Fd$$

$$\lambda = \frac{c}{f}$$

$$\text{Average Velocity} = \frac{v_i + v_f}{2}$$

$$P = \frac{W}{\Delta t}$$

$$T = \frac{1}{f}$$

Variables

a = acceleration

c = specific heat

d = distance

f = frequency

F = force

Δh = change in height

I = current

KE = kinetic energy

λ = wavelength

m = mass

p = momentum

P = power

PE = gravitational potential energy

q = charge of particle

Q = heat

R = resistance

Δt = change in time

ΔT = change in temperature

T = period

v = velocity

v_i = initial velocity

v_f = final velocity

Δv = change in velocity

V = voltage

W = work

Δx = displacement

Definitions

c = speed of electromagnetic waves = 3.00×10^8 m/s

G = Universal gravitational constant = $6.67 \times 10^{-11} \frac{\text{N} \cdot \text{m}^2}{\text{kg}^2}$

k = Coulomb constant = $8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$

$g \approx 10 \text{ m/s}^2$

1 N = $1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$

1 J = 1 N · m

1 W (watt) = $1 \frac{\text{J}}{\text{s}}$

High School Introductory Physics
Spring 2010 Released Items:
Reporting Categories, Standards, and Correct Answers*

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
1	339	<i>Heat and Heat Transfer</i>	3.3	A
2	339	<i>Motion and Forces</i>	1.5	C
3	340	<i>Heat and Heat Transfer</i>	3.2	A
4	341	<i>Waves and Radiation</i>	6.1	C
5	341	<i>Motion and Forces</i>	1.1	B
6	342	<i>Electromagnetism</i>	5.1	C
7	342	<i>Electromagnetism</i>	5.2	C
8	342	<i>Motion and Forces</i>	2.5	A
9	342	<i>Heat and Heat Transfer</i>	3.1	B
10	343	<i>Motion and Forces</i>	2.4	A
11	343	<i>Waves and Radiation</i>	4.1	D
12	344	<i>Heat and Heat Transfer</i>	3.4	
13	345	<i>Waves and Radiation</i>	6.2	C
14	345	<i>Waves and Radiation</i>	4.6	C
15	345	<i>Electromagnetism</i>	5.3	C
16	345	<i>Waves and Radiation</i>	4.3	B
17	346	<i>Motion and Forces</i>	1.7	B
18	346	<i>Motion and Forces</i>	2.3	C
19	346	<i>Electromagnetism</i>	5.6	C
20	347	<i>Waves and Radiation</i>	4.2	A
21	347	<i>Motion and Forces</i>	2.1	D
22	347	<i>Motion and Forces</i>	2.5	B
23	348	<i>Motion and Forces</i>	1.6	
24	349	<i>Electromagnetism</i>	5.5	C
25	349	<i>Heat and Heat Transfer</i>	3.4	C
26	349	<i>Motion and Forces</i>	1.5	B
27	350	<i>Waves and Radiation</i>	4.1	B
28	350	<i>Motion and Forces</i>	2.2	A
29	351	<i>Waves and Radiation</i>	4.2	B
30	351	<i>Heat and Heat Transfer</i>	3.3	C
31	351	<i>Motion and Forces</i>	1.8	B
32	352	<i>Waves and Radiation</i>	6.2	
33	353	<i>Electromagnetism</i>	5.2	B
34	353	<i>Motion and Forces</i>	1.4	A
35	353	<i>Electromagnetism</i>	5.1	A
36	353	<i>Motion and Forces</i>	2.4	B
37	354	<i>Motion and Forces</i>	1.2	C
38	354	<i>Electromagnetism</i>	5.4	C
39	354	<i>Waves and Radiation</i>	4.5	B
40	354	<i>Motion and Forces</i>	1.2	A
41	355	<i>Waves and Radiation</i>	4.4	C
42	356	<i>Motion and Forces</i>	1.3	D

Item No.	Page No.	Reporting Category	Standard	Correct Answer (MC)*
43	356	<i>Waves and Radiation</i>	4.3	A
44	357	<i>Motion and Forces</i>	2.1	
45	358	<i>Electromagnetism</i>	5.5	

* Answers are provided here for multiple-choice items only. Sample responses and scoring guidelines for open-response items, which are indicated by shaded cells, will be posted to the Department's website later this year.